Dynamic Design: The Cleanroom

Suiting Up

TEACHER GUIDE

BACKGROUND INFORMATION

Johnson Space Center

A cleanroom is a room within which the concentration of airborne particulate matter is kept strictly within specified limits. Particulate matter can be anything ranging from dust to skin flakes. In other words, the cleanroom is a specially constructed, enclosed area, environmentally controlled with respect to airborne particles, temperature, humidity, air flow patterns, air motion, and lighting. Cleanrooms were first developed during World War II during the development of bombs.

Eighty percent of contamination in the cleanroom originates from the people, fifteen percent comes from equipment, and about five percent from room or filtration defects. Therefore if people are not properly gowned while in the cleanroom, all of the resources used to design and construct the cleanroom are wasted. Skin flakes break up and disperse during normal activity. Human beings shed one outermost layer of skin cells every 24 hours. The movement of the body and clothes cause the skin to flake off much like leaves falling from trees in autumn. Normal lab coats act something like a bellows by forcing contaminants into the air. Particles can escape from a worker into the atmosphere of the cleanroom through the fabric, seams in the fabric, from the surface of the fabric, through zippers, from uncovered portions of the body, and lastly, through respiration. Cleanroom garments help to eliminate this source of contamination by acting as a filter that prevents human particulate matter from entering the atmosphere of the cleanroom. Garments used in cleanrooms are made from tight weave synthetic fabric that generates no contaminants. The fabric is often made of continuous multi-filament yarns interwoven with nylon filament thread. These conductive filaments can be worn in a pin-stripe or grid-like pattern. Synthetics are non-absorbent, resistant to numerous chemicals and non-linting. However, they are unable to "breathe."

Body coverage depends on the needs of the user and cleanroom cleanliness class (see the “Levels of Clean” activity). Coveralls have a full-length zipper from the crotch to the base of the collar, with a covered fly. Snaps are recommended for the fastening of the collar. Coverall pant legs should fit into booties (cleanroom shoes). Foot covers include cleanroom shoes, shoe covers, and cleanroom booties.

Masks, or hoods, (as shown above), are used to protect contamination that may come from the mouth. Hoods should fit snugly around the head, covering all hair in order to contain loose hair and skin flakes. Hoods provide total coverage of the head and neck, and also have a full shoulder drape that fits inside the coverall. Gloves are worn to prevent cross contamination of the hands. Gloves should be worn in such that they overlap the sleeve of the coverall.

Attention to detail is of the utmost importance when dressing to go into the cleanroom. There are several steps that need to be completed in a certain order while robing. Let’s consider that you are suiting up for the Genesis cleanroom. Before you enter the De-integration room, you must walk on a special tacky mat, which removes dust and dirt from shoes, and then put on shoe covers. There are two different cleanroom suits for the Genesis lab. The first has a soft hood and coveralls that are worn over regular clothes. The second suit is the Dryden suit, which comes with the full helmet, face mask and HEPA filtered breath packs. The former suit is worn during cleaning and the latter is worn when wafers are handled. From the De-integration room you may enter the changing room. Here you remove regular clothes and jewelry and put on clean cotton medical scrubs as undergarments for the cleanroom suit. Next, you suit up in clean room garments. When dressing for the cleanroom, you must dress from the head down, putting on the appropriate head cover, then the basic garment, followed by the shoe covers and finally, the hand covers. During the robing procedure no part of the garment should touch the floor. The hood should be tucked inside the basic garment and the cuffs for both wrists and ankles snapped shut. You put on cleanroom boots over the garment pant legs, and pull basic gloves on over garment arm cuffs. Once the dressing is complete, some cleanrooms have an air shower located in an air lock to remove any dust that

may still be on exposed skin. Once the work being done in the cleanroom is completed, disrobing occurs in the opposite order as robing. Soiled clothes are placed in a collection area.

In this activity, students will learn about the importance of contamination control. Through a teacher-led discussion, students will discover the different types of industries that use cleanrooms. Students will read and discuss the student text "Suiting Up" as they make a connection between dressing for a specific activity and dressing for cleanroom work. The student activity centers on drawing a parallel between suiting up for the Genesis cleanroom and dressing to do a certain job or activity, and presenting the findings to the class.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Science and Technology

Abilities of technological design

Understandings about science and technology

Science in Personal and Social Perspectives

Science technology and society

Grades 9-12

Science As Inquiry

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Science and Technology

Abilities of technological design

Understandings about science and technology

(View a full text of the National Science Education Standards.)

LANGUAGE ARTS STANDARDS ADDRESSED

Standard: 8 Demonstrates competence in speaking and listening as tools for learning

Level III Grades 6-8

Listening and Speaking

Demonstrates competence in speaking and listening as tools for learning.

Conveys a clear main point when speaking to others and stays on the topic being discussed.

Presents simple prepared reports to the class.

Level IV Grades 9-12

Listening and Speaking

Adjusts message wording and delivery to particular audiences and for particular purposes (e.g., to defend a position, to entertain, to inform, to persuade).

Makes formal presentations to the class (e.g., includes definitions for clarity; supports main ideas using anecdotes, examples, statistics, analogies, and other evidence; uses visual aids or technology).

Responds to questions and feedback about own presentations (e.g., defends ideas, expands on a topic, uses logical arguments).

(View a full text of the McREL Compendium of Standards and Benchmarks for K-12 Education)

MATERIALS

For each group of three to four students:

- Student Activity, "Suiting Up"
- Student Text, "Suiting Up"
- Cleanroom Interactive Field Trip
- Cleanroom Technology: NASA's Genesis Mission video tape

PROCEDURE

1. Read the following to students:
   In the 1977 film "The Boy in the Plastic Bubble," John Travolta played a high school student named Todd who was born without any immunity. The film was based on a true story about a young Texas patient who lived and died in a germ-free plastic sphere. From birth, he had to live his life inside of a room sealed off from the outside world. All of the air that went into this room was filtered so that there were no microorganisms in his environment. From the outset Todd's parents were heartbroken that they could not touch their baby. He finally came home from the hospital at age four but had to live inside a plastic sphere inside his house. Children with this disease called severe combined immune deficiency (SCID)--commonly known as "bubble boy" disease--inevitably died from common infections. Researchers at Duke University Medical Center are now reporting that the disease can be cured in many cases if diagnosed and treated early enough.

2. Ask students questions like the following:
   - Why was Todd placed in this cleanroom?
   - Why could Todd's parents not touch him?
   - Humans carry many germs in everyday life. Why are the germs not harmful to us?
   - In high school, Todd said he never had even the smallest "cold." Why is this?

3. Explain to students: While in the hospital, Todd was visited by astronaut Buzz Aldrin. Aldrin talked with Todd about having to go through a quarantine period after he and fellow Apollo 11 astronauts returned from the moon.

   Watch a short movie of this event by going to:
   http://lava.larc.nasa.gov/ABSTRACTS/LV-1998-00036.html

   What were some of the similarities and differences between Aldrin's quarantine and Todd's?

4. In the case of Todd, he was being protected from germs from others. Have students work in small groups to answer the following items:
   - List some experiences in your own life when you need to keep things clean.
   - Why is it important that we keep these items clean?
   - What are some examples in the science lab?
   - How do we control contamination?

   Answers may include:

Alternate Stragegy Tip
Journaling Activity

Show excerpts from the film "The Boy in the Plastic Bubble," where Todd watches his high school class on closed circuit TV, then later when he goes to high school for the first time in what looks like an astronaut suit.

Ask students to write about one of the following topics as an entry in their journal:

- Describe a day in the life of a person who would have to wear an astronaut-like suit to high school. Describe some of the events of the day and the feelings that person may have.
- Describe what it would be like to not have any physical contact with the outside world. What would you do? What would be some of the advantages and disadvantages?
- At the end of the movie, Todd must decide whether to continue to live in this environment or leave to spend time with a girl he loved, and risk dying. What decision would you make? What would be some of the factors that would influence your decision?

- medical industry: doctors and nurses in hospital rooms washing hands and sterilizing equipment to keep germs from infecting patients;
- food industry: agriculture for processing and storing foods (canning or freezing), food preparation in the cafeteria to prevent contamination from getting on food;
- waste industry: human waste and waste water treatment to prevent the spread of disease;
- science lab: students working with clean glass wear in the chemistry lab and preventing cross contamination of chemicals to control an experiment; and
- washing hands before and after handling animals to prevent contaminating humans and animals.

5. Explain to students that hospitals, the electronics industry, and the Genesis mission all use cleanrooms. The levels of clean vary depending on what is being done in the cleanroom. As we have mentioned, hospitals are careful to eliminate any microorganisms from operating rooms so not to infect patients. The electronics industry is not as concerned about germs, but dust and static may be a problem. Ask students why it would be important to build circuit boards and computer chips in a clean environment.

6. Read the following excerpt from the Genesis fact sheet, "*The Genesis Mission: An Overview*." "Once in position the Genesis spacecraft will uncover its collectors. Particles of solar wind will embed in ultra-pure silicon wafers and other pure materials." Ask students why it is important that the wafers be made from pure materials? (Students may suggest that because scientists are trying to find out the elemental abundances of solar wind, they need to be able to differentiate between contamination and the sample which are both the size of atoms.)

7. Now ask students to synthesize what has been discussed. Ask: What would happen if there was contamination in any of these cases? What would happen? Would the mission be a failure? Would the computer not work? Would the patient die?

8. Let's say that you have two videos that have the same program. One was kept in its box and cared for in a way that is best for the video. The other was dropped onto the side of the road during a windstorm. Assuming that it would still play, what would the difference in the quality of the videos be?

9. What do hospitals, electronics industry, Genesis and the video have in common? (in order to have optimal performance the conditions in which each operates must be clean). What are some of the issues when dealing with contamination of sensitive items? How does the cleanroom fit into this?

10. Show *Cleanroom Technology* video segment that shows the scientists suiting up.

11. Have students read the student text: "Suiting Up."

12. Students should complete the simulation in the *Cleanroom Interactive Field Trip* garment room, in which they prepare to enter the cleanroom.

13. Have the students complete the activity, "Suiting Up." Distribute the Student Activity, "Suiting Up: Focus on Communication." Tell students that they will be working on a class presentation by working in pairs or individually. Ask students to read the four paragraphs and decide with whom they would like to work.

14. Tell students that they should first choose a type of attire that relates to an activity. Students should understand that they may choose attire that is not listed on the student activity sheet. Before students decide on which approach they would like to present. Have the students read the sections "Designing Bunny Suits" and "There is a Sequence" from the student activity. Next students should determine the approach to their presentation (i.e. design or getting dressed).

15. Once students have chosen the approach, they are ready to develop the final product. Students who need guidance in developing the

Alternate Strategy Tip

Listening Notes: During the presentation ask students in the audience to complete listening notes by using a simple format illustrated below. Example in italics.

Label	Notes
Sequence	*1. Hold up the coverall.* *2. Grasp the right wrist…* *3. Grasp the left wrist…* *4. Place the legs of the…*

presentation should refer to the outline provided at the end of the student sheet.

16. Allow students time to prepare for their presentation. Finally, after a reasonable amount of time, students should make their presentation to the class.

TEACHER RESOURCES

http://www.genesismission.org/educate/kitchen/foodthought/Informative.pdf
Speaking to Inform: Building a Powerful Message